CURRENT AWARENESS OF GENETICALLY MODIFIED FOOD ISSUES

PROJECT F99

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SUMMARY

This report is one of a series intended to provide the New Zealand Ministry of Health with an independent source of current information on issues related to genetically modified foods. This report covers developments in the period October - December 2001.

1 INTRODUCTION

This project is intended to provide the Ministry of Health with an independent source of current information on genetically modified foods (GMFs). It is intended to include:

- scientific issues concerning safety, detection, and nutritional quality of genetically modified foods;
- the legislative situation overseas.

The aim is to condense this material into a useful form so that the Ministry can respond to issues and enquiries from other government agencies, industry and the general public. The project also aims to provide information to support the development of an appropriate enforcement strategy on standards for genetically modified foods.

This is the second report for the 2001/2002 year and covers events from 30 September to 24 December 2001.

Wider issues concerned with environmental or social effects of genetic modification and genetically modified organisms (GMOs), biodiversity, gene transfer, insect resistance etc, are only covered peripherally in this report. This reflects the division of responsibility for genetically modified material, between the Ministry of Health and the Australia New Zealand Food Authority (ANZFA) for GMFs on one hand, and the Environmental Risk Management Authority (ERMA) for GMOs on the other.

For consistency, some alternative terms have been standardised in this report. "Corn" and "maize" are interchangeable; in this document "corn" is used throughout. Canola is a genetic variation of rapeseed (or oilseed rape) developed by traditional plant breeding to be low in both erucic acid and glucosinolates ("double low" variety). In this document "rapeseed/canola" is used throughout.

Abbreviations used throughout this document:

EU: European Union
FDA: Food and Drug Administration (US)
USDA: United States Department of Agriculture
EPA: Environmental Protection Agency (US)
MAFF: United Kingdom Ministry of Agriculture Fisheries and Food
ACNFP: Advisory Committee on Novel Foods and Processes (UK)
ACRE: Advisory Committee on Releases to the Environment (UK)
ERMA: Environmental Risk Management Authority
ANZFA: Australia New Zealand Food Authority

An important source for this project is the AgNet email newsletter produced by staff at the University of Guelph. Information and archives of the newsletter can be found at:

http://www.plant.uoguelph.ca/safefood/

2 DETECTION OF GENETICALLY MODIFIED FOODS: RECENT DEVELOPMENTS

2.1 Protein Based Testing for NK603 Corn

Monsanto's Roundup Ready corn variety NK603 has been approved by the USDA for commercial planting and is intended to replace the previous version of Roundup Ready corn, GA21. Commercial immunoassay based test kits to detect the EPSPS protein present in NK603 in commodity corn have been released by Strategic Diagnostics and Neogen.

The GA21 variety of Roundup Ready corn currently represents the majority of the US genetically modified corn plantings. No immunoassay detection methods were able to be developed for this crop, as the native EPSPS protein and the introduced version are very similar, and antibody based methods are unable to differentiate them.

2.2 Protein Based Testing for Cry9C from Starlink Corn in Corn Based Foods

The commercially available immunoassay kits to detect the Cry9C protein in Starlink corn have normally been used to detect the protein in corn, cornmeal or grits. The degradation of proteins during food processing usually means that the antibodies in such test kits will not recognise the protein in processed foods. A collaborative study has been conducted investigating the capability of a Cry9C detection kit manufactured by Envirologix to detect the protein in processed foods: starch, refined oil (not bleached or deodorised), soft tortillas, tortilla chips, corn puffs, corn flakes, corn muffins and corn bread (Trucksess, 2001).

Although the study was smaller than a normal AOAC collaborative trial, it was conducted due to the urgent need for a validated protein based method. The data indicated that the method was applicable for the determination of Cry9C protein in the 8 types of corn based products at levels of $\geq$ 2 ng/g. It was recommended that AOAC International consider approving the method.

2.3 Check Sample Programmes

There are a number of organisations who offer check sample or proficiency programmes so that laboratories can assess their performance in the analysis for GM materials. Now the American Association of Cereal Chemists International Check Sample and Proficiency Testing Service has been introduced, offering samples of ground corn or soybean (see: http://www.scisoc.org/aacc/checksample).

The USDA Grain Inspection, Packers and Stockyard Association (GIPSA), who provide performance verification services for test kits for GM materials in corn, will also be launching a check sample programme in January 2002 (see: http://www.usda.gov/gipsa/biotech/biotech.htm).

2.4 Quantitative Methods for GMO Detection

Various legislative thresholds for labelling or adventitious contamination have created the need for methods that can accurately quantitate the amount of GM material in seeds, food or food ingredients. Considerable effort is being expended to develop such methods in Europe, based on quantitative polymerase chain reaction (PCR) techniques. Several recent publications have described collaborative research and the experiences of laboratories in such analyses.

The experiences of three European food control laboratories in validating quantitative PCR methods showed that the limit of quantification was 30-50 target molecules (Hübner et al., 2001). Thus the limit of quantification depends on the genome size of the plants and will range from 0.02% for rice, to 0.7% for wheat. The precision of quantitative PCR detection methods, expressed as relative standard deviation (or coefficient of variation), varied from 10-30%.

Three related reports by research groups in England, Norway and Belgium have been published on the development of quantitative assays specific for Roundup Ready soy, which target the junction of the inserted DNA and the plant genome:

- Event specific detection of Roundup Ready soy using real time PCR, either using Taqman chemistry on the ABI PRISM7700 or using Scorpion primers on the Roche Diagnostics Lightcycler (Terry and Harris, 2001);
- An event specific PCR system for Roundup Ready soy developed for the Lightcycler system (Taverniers et al., 2001). A detection limit of 5 copies of the target region was determined;
- An event specific real time PCR detection method with Taqman chemistry on the Lightcycler, which targets the junction between the *nos* terminator and the plant genome (Berdal and Holst-Jensen, 2001).

A commentary describing the three EU funded research efforts has also been published (Einspanier, 2001).

2.5 Sampling Grain Shipments to Detect Genetically Modified Seed

A paper examining the parameters of sampling to test for the presence of genetically modified seeds has been published (Whitaker et al., 2001). Essentially, for a given level of genetically modified seeds, the sample size determines the uncertainty associated with estimating the true level, or the ability to classify lots into categories above or below a tolerance limit. Thus it is up to the buyer and seller to determine the level of acceptable risk of accepting a non-complying shipment; increasing the sample size will reduce the risk.

3 GMF APPROVALS

The full table listing regulatory approvals of GM crops for human food use has not been included in this report. There has been relatively little change to the table included in the June 2001 report. The only completely new transformation event to receive approval for human food use is given below. As well as the approval of New Leaf Plus potatoes noted in the last report, NK603 corn, a Bt11 sweetcorn (additional to the dent corn approval) and 260-05 high oleic soy have also been approved for food use in Japan.

ANZFA Application Number	Plant	Company	Trait	Brand Names	Variety (Line) Names	Transformation event	Food Use Approvals and Consultations
	Corn	Dow Agrosciences Ltd(Mycogen) and Pioneer (DuPont)	Lepidopteran insect (European corn borer) resistant (*cry1Fa2* gene from *Bacillus thuringiensis* var. *aizawai*) and Glufosinate-ammonium herbicide tolerant	Herculex 1		TC1507	USA: FDA 2001

4 LEGISLATIVE POSITION OF OVERSEAS GOVERNMENTS REGARDING GENETICALLY MODIFIED FOODS

4.1 Food Use Approvals

4.1.1 Bt corn approvals in the United States

The United States EPA has responsibility for approving the use of GM crops that contain Bt toxins, which are classed as pesticides. In the last report from this project (September 2001) the status of EPA renewals of GM Bt crop registrations was reviewed. Bt cotton crop registrations were renewed on 30 September 2001 for a further five years, with no significant changes in the conditions of registration. The EPA concluded that there was no evidence that insect resistance to Bt toxins was developing, and requiring farmers to reduce their use of such crops would result in unacceptable economic losses.

The decision on Bt corn crops was announced on October 15, 2001. The registrations for use of GM corn that expresses Bt toxins were approved for an additional seven years. The review found that Bt corn did not pose risks to human health or the environment. The renewed registrations require companies to routinely monitor and collect data on insect resistance, human health or environmental effects.

More information is available from:

http://www.epa.gov/pesticides/biopesticides/

4.1.2 EU legislation

The new proposed EU legislation related to increased labelling and traceability (described in the September 2001 report from this project) has been the subject of much controversy, particularly between the US and Europe. One option that the US is considering is a challenge before the World Trade Organisation, but that requires the proposed legislation to be in place (Fox, 2001).

Within Europe, the United Kingdom Food Standards Agency has also rejected the proposals, calling them “unworkable, unscientific and highly costly” (Source: The Independent 30 September 2001 via AgNet).

The new legislation will not come into force until October 2002. In a bid to resume approvals before then it was proposed that new licences could be granted on the basis of a voluntary commitment from the applicants similar in scope to the compulsory requirements in the directive (Source: Nature 18 October 2001 via AgNet). However this idea found little favour at a meeting EU Environment Ministers in October 2001, despite concerns from the European Commission that the moratorium on GM approvals may be challenged under international law (Source: Reuters 29 October 2001 via AgNet).

4.1.3 China

Although China announced new rules for the importation of GM commodities in June 2001, including inspection and documentation, further details have yet to be released. This was affecting trade with the United States, as shipments of US soy were being held up. A further consequence is that China may begin to experience shortages of soy (Source: Reuters 8 October 2001 via AgNet). Subsequently China has announced that US soybean imports will be allowed until the new rules are announced, provided the shipments are accompanied by a government certificate saying they are safe for the environment, safe for humans to eat and safe for livestock feed (Source; New York Times 3 December 2001 via AgNet).

4.1.4 Brazil

Brazil has yet to approve the commercial growing of genetically modified crops, although GM soybeans from Argentina are acknowledged to be widely grown in southern parts of the country. Approval of GM soy by Brazil would represent a major shift in the GM status of the worldwide crop. According to USDA estimates, Brazil will produce 41.5 million tonnes of soybeans in 2001/2002, compared with 75.1 million tonnes in the US and 27.0 million tonnes in Argentina. The top three producers, the US, Argentina, and Brazil, account for 52 million of the 57 million tonnes of soybeans estimated to be exported throughout the world each year (Source: Reuters 6 November, 2001 via AgNet).

4.1.5 Canada

In February 2001 the Royal Society of Canada released a report entitled: Elements of Precaution: Recommendations for the Regulation of Food Biotechnology in Canada. In November 2001 the government of Canada responded with an action plan to address these recommendations. The action plan is a joint effort by Health Canada, the Canadian Food Inspection Agency, Environment Canada, Agriculture and Agri-Food Canada and the Department of Fisheries and Oceans. It will address six main areas:

- Substantial equivalence;
- Use of precaution;
- Transparency and increasing public confidence;
- Potential human health impacts;
- Environmental safety;
- GM animals.

The full action plan is available from:

http://www.inspection.gc.ca/english/ppc/biotech/tech/reprape.shtml

4.1.6 South Africa

A paper reviewing the adoption of GM crops in South Africa has been published. This reports that following the passing of the Genetically Modified Organism Act, Act 15 (passed in 1997 and implemented in 1999), small quantities of GM cotton (for clothing) and corn (for animal feed) are being grown on a commercial basis in South Africa. The further adoption of

these crops will depend on continued improved yields and reduction in pesticide use to offset the higher cost of the seeds. The full paper is available at:

http://www.agbioworld.org/biotech_info/topics/agbiotech/africa.pdf

The first biotechnology derived food crop has now been planted in South Africa. Roundup Ready soybeans were approved for commercial release early in 2001 and the first crop (17,500 acres) has now been planted (Source: Monsanto press release 20 December 2001 via AgNet).

4.1.7 GM functional foods and nutriceuticals

To date, most commercialised GM crops have contained traits (herbicide tolerance, insect resistance) which have agricultural value. Future developments will include plants which have been engineered to have either enhanced levels of existing chemicals or totally new components with potential human health benefits. These will provide a challenge for regulators, as legislation controlling such nutraceuticals and functional foods is not finalised for such products, let alone GM versions. A review of the legislative situation in Europe and the US with regard to GM foods has been published (Kleter et al., 2001), which also considers how GM plants with altered composition for health purposes might fare under the legislation. In the US it appears that such foods are most likely to be handled as a food supplement; in Europe it may be preferable to submit such foods as medicines (despite the costly and lengthy approval process for such medicines, public acceptance of GM medicines is greater). A more detailed analysis of the issues is available from:

http://www.voedselveiligheid.net/nutraceuticals/

4.2 Labelling

4.2.1 Mandatory labelling bill defeated in Canada

The Canadian House of Commons has defeated a bill (C-287) that would have required labels for all food containing genetically engineered ingredients at greater than 1%. This was despite the Health Minister having declared his support for mandatory labelling. Voluntary labelling has been recommended for Canada by the Royal Society of Canada and the Canadian Biotechnology Advisory Committee (Source: Various news reports October 2001 via AgNet).

4.2.2 GM free labelling in the United States

The United States FDA is continuing to review the 55,000 comments it received on the draft guidelines for voluntary labelling of foods developed using biotechnology (or not), issued in January 2001. The draft guidelines can be viewed at:

http://www.cfsan.fda.gov/~lrd/../~dms/biolabgu.html

Meanwhile, a number of natural foods companies in the US have been warned by the FDA that they are misleading consumers by labelling their products as free of genetic modification. The regulators are concerned that consumers equate such a claim with a healthier products. Such claims are also difficult to substantiate; a survey by the Wall Street Journal in April 2001 found that of 20 products claiming to be GM free, 16 contained evidence of genetic material used to modify plants (Source: Wall Street Journal 20 December 2001 via AgNet).

5 CURRENT DEVELOPMENTS

5.1 Resources

5.1.1 Overview of European Commission research on GMOs

Over the last 15 years the European Union has financed 81 research projects (at a cost of approximately $150NZ million) into aspects of risk assessment and safety of genetically modified crops and products made from them. A summary report on this extensive research programme was released in October 2001. At the same time a European Round Table on GMO safety was launched. The press release for these events stated: "Research on the GM plants and derived products so far developed and marketed, following usual risk assessment procedures, has not shown any new risks to human health or the environment, beyond the usual uncertainties of conventional plant breeding. Indeed, the use of more precise technology and the greater regulatory scrutiny probably make then even safer than conventional plants and foods; and if there are unforeseen environmental effects – none have appeared as yet – these should be rapidly detected by our monitoring requirements." This statement has been widely quoted in the media.

The press release is available at:

http://europa.eu.int/comm/research/press/2001/pr0810en.html

The research report includes the following areas:

- Environmental and agricultural effects (horizontal gene transfer, effects on non-target insects, gene flow, pollen dispersal);
- Genetically modified micro-organisms and potential effects on indigenous bacteria;
- Field use of genetically modified micro-organisms for pest and disease control;
- Food safety, consumer issues, detection;
- Bioremediation using GM micro-organisms;
- Novel techniques to track GMOs;
- Transgenic fish containment;
- GM technology for better vaccines.

The full report is available from:

http://europa.eu.int/comm/research/quality-of-life/gmo/

5.1.2 CAST report on US regulatory process

The Council for Agricultural Science and Technology (CAST) was established in 1972 and is a US based non-profit organisation composed of 37 scientific societies as well as individual members. Its mission is to assemble, interpret and communicate science-based information on food, environmental and agricultural issues.

A CAST issues paper from October 2001 examined the US regulatory process for crops developed through biotechnology. The authors concluded that the flexible case by case approach adopted by the regulatory agencies was a strength and should be retained, as well as

being made mandatory. A clear need was identified for improved access to information and opportunities for public input. The full 14 page paper can be viewed at:

http://www.cast-science.org/pubs/cropregulation.pdf

5.1.3 The Plant Journal: Special issue on plant GM technology

This scientific journal has created a web-based resource for the publication of commissioned papers related to biotechnology. Amongst the papers currently available is one that reviews "Assessment of the food safety issues related to genetically modified foods". Another provides an overview of the Monarch butterfly controversy and the recently published studies on potential effects on non-target insects. The journal is available from:

http://www.blackwell-science.com/~cgilib/jnlpage.asp?Journal=tpj&File=tpj

5.1.4 Recent books

"First Fruit" by Belinda Matinneau (McGraw Hill ISBN 0071360565, 2001) is a history of the development of the Flavr Savr tomato written by a scientist who was part of the development team at Calgene. In a review (McHughen, 2001) the book is described as a history of the company, its scientists, and the management decisions that ultimately led to the failure of the product. There is little technical detail, and the book concentrates on the human and business aspects of the story.

"Lords of the Harvest' by Daniel Charles (Perseus Publishing, ISBN 07382021, 2001) is a history of the use of biotechnology in agriculture, and includes considerable technical detail about the process of creating genetically modified crops.

5.1.5 Agbios database

AgBios (Agriculture and Biotechnology Strategies Inc.) is a Canadian consulting company involved in the biotechnology area. With funding from the International Service for the Acquisition of Agri-Biotech Applications (ISAAA) and Monsanto they have released a CD-ROM which contains their database of details on internationally commercialised transgenic crops. The disc also contains a bibliography of scientific reports on genetically modified crops and training materials for education. A free copy of this useful CD ROM can be obtained from:

http://www.agbios.com/default.asp

5.1.6 Asian Development Bank analysis

The Asian Development Bank has prepared an analysis of agricultural biotechnology in the South East Asian region. It examines the opportunities and risks of using the technology to reduce poverty and achieve food security in Asia, as well as the role to be played by the bank. One chapter provides an overview of the current status of biotechnology in various countries in the region. The entire report can be downloaded from:

http://www.adb.org/Documents/Books/Agri_Biotech/default.asp

5.1.7 EU website

European legislation and other documents related to GMOs have now been consolidated under a single website:

http://europa.eu.int/comm/food/fs/gmo/gmo_index_en.html

5.2 Human Health

5.2.1 Concerns raised about *Bacillus anthracis* and *Bacillus thuringiensis*

In October 2001, an article appeared on the Institute for Science in Society (ISIS) website discussing biopesticides and bioweapons. Part of the article raised the possibility of combination of *Bacillus anthracis* and *Bacillus thuringiensis* bacteria as the toxin genes for each species occur on plasmids (circular DNA molecules that can replicate independently of the chromosome). These plasmids may be exchanged. The possibility was also raised that *Bacillus anthracis* could recombine with the *Bacillus thuringiensis* endotoxin genes used in GM crop plants to produce a bacteria that was toxic to people and insects. The article was widely distributed, and can be read in full at:

http://www.i-sis.org/biopesticide&bioweapons.php

Articles dismissing this possibility have been published at:

http://www.agbioworld.org/listarchive/view.php?id=1303

and

http://www.foodstuff.org/News/PressReleases/110201.htm

5.3 Consumer Issues

5.3.1 GM material in foods in South East Asia

Despite assurances that it would avoid GM soy in its Gerber baby food products, Novartis has admitted that Greenpeace reports of GM material in products sampled in the Philippines are correct. They are seeking an alternative supplier (Source: Reuters 4 October 2001). Greenpeace in Thailand has also reported finding GM material in Novartis Gerber rice with fruit baby cereal, as well as Nestle Cerelac mixed vegetable, Goldroast instant cereal, Nissin cup noodles, Vienna Pork CP and Pringles potato crisps (Source: Bangkok Post 16 October 2001 via AgNet).

Greenpeace has also released results from testing which indicate the presence of GM soy or corn in foods from South East Asia: Jack and Jill Tostillas (Smokey Barbecue Flavored), Granny Goose Kornets (Natural Flavor), Knorr Crab and Corn Chinese Soup, Maggi Cup Sarap Chicken Arrozcaldo, Campbell's Condensed Soup Chicken with Rice, Swift Meatloaf

embotido style, Swift Cheesy Hotdog, Hormel Vienna Sausage, Purefoods Chorizos bilbao style, Purefoods Chicken Nuggets Classic with honey barbecue sauce, Campocarne Chicken Hotdog, CDO Corned Beef, Ensure Complete Balanced Nutrition (vanilla flavor) and Quick Chow Instant Pancit Palabok (Business World 1 November 2001 via AgNet).

5.3.2 Denmark

The Danish Ministry of Food, Agriculture and Fisheries is planning to conduct another random survey of food for the presence of GM soy and corn material. An earlier survey from February to July 2001 found that approximately one third of samples contained more than 1% GMO and none were labelled. The new survey will be published in January 2002 (Source: FAS online at http://www.fas.usda.gov/fassearc.html November 2001 via AgNet).

5.4 Agricultural and Environmental Issues

5.4.1 Genes from GM crops found in Mexican corn

Initial news reports about this finding began to appear in early October 2001, but the letter to the journal Nature (Quist and Chapela, 2001) from scientists at the University of California did not appear until late November.

The letter to Nature indicates that researchers at the University of California found genetic elements commonly used in genetically modified crops in the genomic DNA of native (or "criollo") landraces of corn from four standing fields in two locations of a remote area of Southern Mexico. "Landraces" are genetically diverse forms of cultivated plants at the interface between wild and domesticated plant species and can be maintained by farmers in dynamic agroecosystems. Holding such traits as resistance to disease, pests, drought, and other stresses, landraces are indispensable for improving modern crops.

The genetic elements found were the 35S promotor (5 of 7 samples tested), the *nos* terminator (2 of 6 samples tested) and the *cry1Ab* Bt toxin gene (1 of 6 samples tested). The flanking regions of DNA adjacent to the 35S fragments were investigated and gave a variety of results: the flanking regions appeared to be either native corn genomic DNA, DNA with some homology to the *adh1* (alcohol dehydrogenase) gene found in some transgenic corn, or else DNA with no homology to any stored sequences. This was suggested to mean that the insertions had been caused by multiple introgression events, probably mediated by pollen. The transgenic DNA construct could have become re-assorted and introduced into different genomic backgrounds, possibly during transformation or recombination (Quist and Chapela, 2001).

These results were unexpected because GM corn has not yet been approved for planting in Mexico, and a moratorium on field trials has been in place since 1998. The results were of concern to some scientists because there may be implications for the biodiversity of native corn varieties and the wild progenitor of domesticated corn, known as teosinte. These varieties act as a reservoir of genetic diversity for breeding purposes. If any of the foreign genes were advantageous, plants carrying those genes could begin to dominate the population

(Source: New York Times 2 October 2001 via AgNet). Other authors have asserted that crossing of genes between native landraces and hybrids developed by crossbreeding has been common, and the integrity of the varieties is preserved by farmer selection of seeds for specific purposes (Source: http://www.agbioworld.org).

Following the discovery by the University of California scientists, Mexico's Ministry of the Environment and Natural Resources announced on September 18 2001 that transgenic elements had been found in corn from 15 sites in Mexico. The elements found were not disclosed. Neither group reported the presence of any protein (Bt toxin) which is the active agent encoded by the genetic insert.

These findings suggest historical cross-pollination, but other explanations are possible. Although commercial planting is not permitted, the import of corn as a commodity and foodstuff is permitted. It is possible that some farmers may be using imported commodity corn as seed stock.

The International Maize and Wheat Improvement Centre (CIMMYT) in Mexico has issued several statements regarding this discovery, including the fact that tests on stored samples of native landraces of corn at the Centre have not found transgenic genetic elements. The statements are at:

http://www.cimmyt.org/whatiscimmyt/init_test.htm

More recently CIMMYT has reported that they have been unable to detect the 35S promotor in field samples, in contrast to the University of California and Ministry for the Environment results (Hodgson, 2002).

5.4.2 Global GM crop area increases in 2001

The International Service for the Acquisition of Agri-Biotech Applications (ISAAA) has stated in a press release that the global area of transgenic crops is likely to reach 50 million hectares (125 million acres) in 2001. This represents a 10% increase on the area planted in 2000. This information will be more fully detailed in the annual overview of commercialised GM crops published by the ISAAA which will be available early in 2002. The detailed report for the year 2000 has also now been released (selected data from a preview of this report were included in the March 2001 report from this project). The press release and the 2000 report are available from:

http://www.isaaa.org/

5.4.3 Indian legislation regarding seed development

India has developed novel legislation that is intended to protect the rights of both plant breeders and farmers (Jayaraman, 2001a). The Plant Variety Protection and Farmers Rights Bill was passed by Parliament on August 9. Plant breeders will have commercial control of a variety they develop, including GM varieties. The latter fall under a category of "essentially derived varieties" that are identical to the parent save for a single character change. The parent material must have been obtained legitimately, and not involve terminator technology.

Royalties are also to be paid for the use of parent material, either farmer derived varieties, or landraces (original traditional varieties).

The bill also recognises the rights of India's 50 million farmers to save and sell seeds produced on their farms, including protected varieties, with the proviso that they are not sold under brand names. India relies on localised farming and an estimated 87% of seeds are currently produced and sold by farmers themselves. The intention is to prevent a takeover of the seed market by a few large companies.

The Bill has been welcomed by companies including Monsanto and Syngenta. The ability to save and sell seeds is likely to be confined to local sales, and will only be feasible for self pollinating crops. In the case of high yielding hybrid varieties, which lose their genetic uniformity after a season, farmers will continue to buy new seeds each year.

The legislation was developed as an alternative to patent protection which is opposed by developing countries. However, there was still an obligation to the World Trade Organisation to protect new varieties developed by breeders.

5.4.4 New GM crops with properties relevant to agriculture

5.4.4.1 Virus resistant papaya

In the previous report from this project (September 2001) the development of virus resistant papaya in Thailand was described. The Thai efforts are part of a Papaya Biotechnology Network of South East Asia, which also includes Indonesia, Malaysia, the Philippines and Vietnam. As well as virus resistant types, delayed ripening papaya are being developed. Malaysia and Vietnam expect to conduct field trials on delayed ripening and virus resistant papaya in 2002 (Source: Global Knowledge Centre on Crop Biotechnology via AgNet 31 October 2001 : see www.agbioworld.org).

5.4.4.2 Rootworm resistant corn

As stated in the previous report from this project (September 2001) two transgenic corn varieties are in development which contain Bt toxins intended to provide resistance to the corn rootworm. Monsanto's Maxguard (or Yieldgard) MON863, that expresses the Cry3B(b) toxin has been developed in commercial hybrids. However, the crop is being held by Monsanto pending food use approval by the US and Japan. A year or so behind in development is the joint Dow Agrosciences and Pioneer HiBred International corn that expresses two proteins from the Bt strain PS149B1.

Both companies intend to crossbreed the corn rootworm resistance trait with a corn borer resistant corn, to produce a "stacked" corn variety. The Dow/Pioneer transformation event will most likely be crossed with their Herculex 1 transformation event (Source: Farm Journal 1 November 2001 via AgNet).

5.4.5 GM cotton illegally grown in India

Approximately 11,000 hectares of Bt cotton have been discovered growing in the western Indian state of Gujurat. No GM crops have been approved by the Genetic Engineering Approval Committee (GEAC) for commercial release in that country. It appears that the hybrid was derived from a Bt variety being developed by Monsanto's Indian partner, the Maharashtra Hybrid Company (Mayhco). Monsanto cannot take action against the seed company, as there is no patent protection for such technology in India; however GEAC is planning to sue the seed company for developing and releasing the hybrid without approval.

The crop has been ordered to be destroyed. However, the incident has highlighted the value of GM crops to Indian farmers, with higher yields and insect tolerance being achieved, and also the inertia of the approval process (Jayaraman, 2001b).

Mayhco have already conducted extensive field trials of GM Bt cotton but have yet to receive approval for commercial release. Field trials of GM rice, corn, tomato and cauliflower are also being conducted in India (Source: Asia Pulse 7 December 2001 via AgNet).

5.5 GM Animal Feed

5.5.1 Overview

A useful overview of the safety assessments conducted on GM materials used as animal feed has been placed on the web by the Canadian consulting firm AgBios (Agricultural and Biotechnology Strategies (Canada) Inc.). The document is available from:

http://64.26.172.90/agbios/gmfeeds.php

5.5.2 GM free soy as animal feed

Demand for GM free soy as animal feed has increased in Europe. Approximately 4 million tonnes of certificated non-GM soy has been imported into Europe in 2001, up from 700,000 tonnes in 2000. The total amount of soy imported into Europe for animal feed has been estimated as 28 million tonnes annually. Most of the non-GM soy derives from Brazil. Although some of the Brazilian soy crop contains Roundup Ready soy, illegally planted with material from Argentina, this occurs mostly in the southern part of Brazil (Source: Reuters 8 October 2001 via AgNet).

5.5.3 Danish organic animal feed

The Danish Plant Directorate has released the results of monitoring of organic animal feed for GMOs. Danish organic feed is required to be GMO free, but almost half the samples (20 of 48) showed evidence of GM derived material, while seven samples had levels greater than 1% (Source: FAS online at http://www.fas.usda.gov/fassearc.html November 2001 via AgNet).

5.6 Miscellaneous

5.6.1 Movement of a gene within a cell

A research group in Illinois has published the results of an experiment whereby a gene was moved from genomic DNA in the tobacco plant cell nucleus, into a chloroplast, which occurs in the cytoplasm (Zhang et al., 2001). This approach is essentially a reversal of what is believed to have occurred during evolution. The gene involved was part of the biosynthetic pathway for the amino acid tryptophan, and movement from the nucleus to chloroplast DNA resulted in a ten fold increase in tryptophan production. This suggests an approach to manipulating cell metabolism to achieve enhanced production of desired products.

5.6.2 Flax as a vehicle for GM pharmaceutical production

A genetically modified herbicide (sulfonylurea) tolerant flax was developed in Canada and approved for commercial planting in 1996. However, due to farmer concerns about GM cross pollination, plantings were discontinued. In November 2001 the suggestion was made (by the developer of the original GM flax) that GM flax could be used for the production of materials for industrial purposes, as flax is not intended for human consumption. To date, most development of GM plant generated biodegradable plastics and pharmaceuticals has concentrated on rapeseed/canola. The suggestion was not supported by flax growers, as the bulk of their crop is exported to Europe, and although most is used for industrial purposes, the residue is fed to livestock (Source: Western Producer 2 November 2001 via AgNet).

5.6.3 Roundup Ready bentgrass

A joint venture between Monsanto and Scotts Company, will soon be producing genetically engineered Roundup Ready bentgrass seed in Oregon. The seeds will be used on golf courses to improve weed control, as well as reduce pesticide and water use. Commercial production is scheduled to begin in late 2002 (Source: Associated Press 20 November 2001 via AgNet).

5.6.4 GM insect field trials

The confined field tests of a GM moth (see the March 2001 report from this project) are now in progress in Arizona. The pink bollworm moths are sterile, and have been engineered to contain a jellyfish gene that makes them glow green. The intention is to study the mating processes of the GM insects with the native population of this important cotton pest. Eventually the researchers hope to substitute the jellyfish gene with a lethal bacterial gene that will kill the moth larvae. This is the first field trial of a GM insect and is being conducted in mesh cages, following approval from the USDA (Source: Wired News 7 December 2001 via AgNet).

5.6.5 *Agrobacterium tumefasciens* genome sequenced

The entire genome of the bacterium *Agrobacterium tumefasciens* has been sequenced as the result of a joint effort by two teams of US scientists (Wood et al., 2001; Goodner et al., 2001). This bacterium is a common tool in genetic engineering and is used to transfer genes into the genome of plant cells by adapting a natural transformation process. It is anticipated

that the sequence will enable scientists to better understand the process and utilise it more effectively. The sequence is publicly available via the DNA sequence database of the National Centre for Biotechnology Information at the US National Institutes of Health.

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